



## Public Health Policies Regarding Hazardous Waste Sites and Cigarette Smoking: An Argument by Analogy

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In 1962, more than a half century after the rise in lung cancer was first detected, the United States Surgeon General convened an Advisory Committee on Smoking and Health (1). After a painstakingly critical review of the literature, the committee noted the causal relationships between smoking and several diseases such as lung cancer (in men). Also noted in the committee's report were conditions for which an association could as of then only be inferred: lung cancer in women, oral cancer, cancer of the esophagus, bladder cancer, emphysema, coronary artery disease, peptic ulcers, and low birthweight infants. A year after publication of the committee's report, Congress mandated that a health warning be placed on cigarette packages (2). Smoking rates began to fall. Over the ensuing 20 years, approximately 750,000 smoking-related deaths were avoided or postponed (3). Americans were responding to the warning.

As indicated in various surveys, the American public strongly believes that toxic industrial chemicals pose a significant threat to human health (4). Communities such as Love Canal, Times Beach, and Bhopal provided well-publicized indications that past industrial practices may indeed be harmful. There may be hundreds of thousands of sites where hazardous wastes were dumped, without controls, in the past. Of concern here are the worst of these, the Superfund sites. These sites are designated by the U.S. Environmental Protection Agency (EPA) under the Superfund Act, known formally as the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), enacted in 1980 (5). The issues Superfund and its amendments were designed to address are as follows: 1) Are there dangerous hazardous waste sites? 2) If there are dangerous hazardous waste sites, how can the risks to the surrounding communities from these sites be minimized? 3) How should the most dangerous sites be remediated (cleaned up)? 4) Who should remediate the sites? 5) Who should pay for remediation? This commentary concentrates on the first two questions.

More than 30,000 hazardous waste sites have been identified under Superfund. The EPA has conducted at least preliminary assessments for most to reduce the number of sites requiring the most serious attention to slightly less than 1200. This shorter list is the National Priority List (NPL). These few sites are known to the general public as Superfund sites.

In an attempt to ensure that the first question above would be addressed, Congress, in the Superfund Act, created the Agency for Toxic Substances and Disease Registry (ATSDR) within the Public Health Service. Thus the law separated the public health component concerning hazardous waste sites from the regulatory agency EPA. The 1986 Superfund Amendments and Reauthorization Act (SARA) passed in the wake of the tragedy at Bhopal, India, better defined ATSDR's role. The ATSDR must conduct public health assessments for sites on EPA's NPL, list the chemicals commonly found at sites, classify these chemicals based on hazards posed, publish summaries of the toxicological data available for each priority chemical, and investigate the effects of exposure to the toxic agents at hazardous waste sites.

After 10 years of experience with Superfund, all parties involved express intense dissatisfaction. Many communities believe the cleanup process is inadequate and too slow. Industry often agrees that the process is too slow, but counters that remediation requirements and costs are excessive. Both groups argue that billions of dollars have been spent under Superfund with little effect. Independent observers agree. The U.S. Office of Technology Assessment (OTA) has noted inordinate expenditures for transaction costs involved in identifying the perpetrators at these sites (the potentially responsible parties) and negotiating with or prosecuting them to ensure that the potentially responsible parties pay. These funds otherwise could have been allocated directly to remediation (6).

At this point it is worth remembering the purpose of Superfund. Do *any* hazardous waste sites pose a human health risk? A committee on environmental epi-

demology appointed by the National Research Council (NRC) found sufficient evidence that hazardous wastes have produced serious health effects in some populations (7). More specifically, the U.S. General Accounting Office (GAO) last year evaluated ATSDR's health assessments (8). The poor quality that was found related in large part to the extreme time constraints for completion of the reports. Nevertheless, GAO noted that ATSDR had no formal plans to reevaluate past assessments and had no procedure for outside, independent review of their health assessments (8).

The battle against cigarette smoking stands in stark contrast to the lack of progress in reducing the threats posed by Superfund sites. Although cigarette smoking still remains a substantial public health threat, it also can be seen as a U.S. public health success story. Today, almost half of all U.S. adults who ever smoked have quit. Because the rate of smoking has decreased, it is estimated that by the year 2000 nearly 3 million lives will have been saved (9).

As obvious as the link between disease and smoking is today, additional risks associated with smoking continue to be identified. In the process of establishing the health risks of either exposure to cigarette smoke or to hazardous wastes, two primary sources of evidence are used: animal bioassays and epidemiology. Industries that benefited from uncontrolled dumping of waste insist that traditional epidemiology must be used to conclusively prove the risks of exposure before hazardous waste sites are remediated. Here we compare exposure to cigarette smoke and exposure to hazardous wastes. Through the comparison, the difficulties of obtaining such epidemiological proof in cases of exposure at Superfund sites will become more clear. For example, although the number of persons exposed involuntarily to tobacco smoke is quite large, only a few thousand persons face potential exposure at any one Superfund site. Nevertheless, the total number at possible risk from all Superfund sites exceeds 40 million (7).

Difficulties of proof are compounded by the fact that exposure to either tobacco smoke or toxic waste involves exposure to complex mixtures. Considered one by one, many of the individual constituent chemicals are known to cause many adverse health effects. In addition, many of the

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adverse effects that could be expected from these complex mixtures often are relatively common conditions in the general population. Thus, the high background rates of disease further compound the difficulty of distinguishing effects in the exposed population. At present, management of the risks posed by cigarette smoking differs greatly from the management of the risks posed by the most dangerous hazardous waste sites. We argue that the response of public health authorities, to a certain extent, should be similar in both situations.

**Problems in Identifying Risks.** As noted above, evidence from human studies (epidemiology) and animal tests (bioassays) can be used to identify health risks. The Surgeon General's 1986 report on involuntary smoking, the passive exposure of non-smokers to cigarette smoke produced by others, recounts the available health-risk evidence (10). Cigarette smoke (mainstream and sidestream) has been shown to be carcinogenic in bioassays. Many individual constituents of cigarette smoke are carcinogenic. Epidemiological studies of smokers also provide evidence of carcinogenicity as well as other adverse health effects. Finally, in his introduction to the 1986 report, the Surgeon General noted that this type of evidence is usually the most that is ever available to assess the risk of human exposure to carcinogens. The case of involuntary smoking, however, is a rare circumstance where there also is epidemiological evidence of carcinogenesis in those exposed to very low doses (10).

In 1989, ATSDR sponsored a conference on traditional methods of tracing adverse effects in human populations back to low-level exposures to chemical agents. A series of papers published in 1990 in the *American Journal of Epidemiology* (11) considered the identification of causes of cancer clusters. Most of these papers recounted, either historically or analytically, the lack of success in such investigations. For example, in a relatively small community of 5000 persons, it would take at least an 8-fold increase in relative risk for a potentially hazardous exposure to be found statistically significant at a 99% level of confidence (12). In contrast, the relative risk of lung cancer from involuntary smoking has been indicated in epidemiological studies to be between 1.2 and 2 (7). More than 1 million persons have been studied to help identify, at a statistically significant level, the risk of involuntary smoking.

The total number of persons who are at potential risk of exposure from improperly disposed hazardous waste also is large. The EPA has estimated that nearly 4 million persons live within a mile of the current Superfund sites. More than 41 million live within 4 miles of Superfund sites (6), but

the population close to any one of the more than 1000 sites tends to be small. The difficulty implicit in studying small populations could be overcome. If information on each site were available in sufficient detail, populations from exposed communities could be aggregated or compared. Unfortunately, the data that would help determine the multiple sites for which similar effects could be anticipated do not yet exist (7).

Another issue relating to the availability of evidence is the determination of exposure. To identify and confirm that a relationship exists between a specific exposure and subsequent development of disease, there must be a measurement or estimate of exposure. In the case of exposure to tobacco smoke, even involuntary smokers are usually aware when they are exposed. Although exposures in past years are difficult to reconstruct, a nonsmoker is still likely to remember the smoking habits of a parent or spouse. In the case of hazardous waste sites, however, it is extremely difficult to reconstruct the past exposures of each individual living near the site. Instead, often the erroneous assumption must be made that all individuals in the community had identical exposures (7).

Current exposure is more easily assessed. Unfortunately, health assessments tend to be based on data initially gathered for purposes related to technical considerations of remediation, such as environmental engineering. (6). Therefore, contravening the intent of Congress in creating ATSDR, the scientific database to date is truly inadequate for the purposes of determining the effects of exposure to hazardous waste sites on human health. The process of gathering information has not yet been designed to adequately address public health concerns (7).

Still more problems in gathering evidence on the effects of hazardous waste exposure relate to the politicized nature of exposure. The anger is well captured in the acronym used to characterize thousands of community groups: NIMBY—not in my backyard! On one hand, academicians warn of recall bias within the context of studying hazardous waste sites (7). For example, individuals who fear that they have been exposed to toxic agents are in many cases more likely to recount past health problems than others who do not believe they have faced any extraordinary risks. Recall bias may therefore lead to an overstatement of effects.

On the other hand, public awareness of potential exposure may have the opposite effect. Community groups often can be quite hostile to governmental agencies, and community organizers may counsel against cooperation with ATSDR, preferring stud-

ies more under community control and preferring action without delay. Many groups are aware that data used in exposure assessments are generated mostly by the potentially responsible parties: those who are thought to have dumped the waste at the site. Health assessments, by definition, are conducted by ATSDR, an agency separate from the one that supervises remediation, EPA. Time spent cooperating with investigating scientists is seen as less fruitful than time spent in bringing pressure to bear upon regulators (13).

Public health agencies traditionally have had difficulty in connecting health effects to environmental exposures, so much so that "departments of public health have become departments of public reassurance" (14). As in the case of ATSDR, health agencies, usually separate from regulatory and enforcement agencies, often cannot effectively redress problems they may detect. This is not to say that health agencies are isolated from political concerns, however. Any agency whose actions result in depressed real estate prices or calls for increased expenditures will likely suffer in the next election or budget cycle. In ATSDR's case, not only is its budget subject to the vagaries of the legislative process, but its funding also must be funneled through EPA.

Furthermore, community organizers are aware that several techniques can be used *not* to find health problems (15). Considering the small groups of exposed persons and inadequately defined exposures characteristic of community problems, a traditional epidemiological study would be a relatively insensitive method to detect potential health effects. A less-than-careful choice of the control and exposed groups would further minimize the chances of finding positive results. Noting the possibility of differences in lifestyle factors, such as smoking, between the exposed and nonexposed group can be used to explain any differences that might be found (14).

Those exposed to tobacco smoke and those exposed to hazardous wastes are confronted by exposure to a veritable toxic soup. In each situation there is exposure to a multitude of chemicals. Some of the

**Table 1.** Known components in tobacco smoke

Year reported	No. of components
1936	120
1959	450
1968	950
1982	3875
1988	3996
1989	>4000

Adapted from the U.S. Department of Health and Human Services (3).

**Table 2.** Chemicals in common: cigarettes and waste disposal sites

Chemical	Carcinogen	ATSDR priority class <sup>a</sup>
<b>Metals</b>		
Arsenic	X	1
Cadmium	X	1
Chromium	X	1
Lead		1
Nickel	X	1
<b>Organics</b>		
Acrolein		3
Benzene	X	1
Phenols		2
Perchloroethylene	X	1
Trichloroethylene	X	1
Toluene		2
Vinyl chloride	X	1
Xylene		3
Polycyclic aromatic hydrocarbons	X	1

Adapted from the U.S. Department of Health, Education and Welfare (16).

<sup>a</sup>ATSDR is required by the 1986 Superfund Amendments and Reauthorization Act to maintain a list of the most common and hazardous chemicals found at National Priority List hazardous waste sites. The ATSDR Priority List was promulgated in the *Federal Register* (17).

chemicals may be well characterized in terms of health effects, but most are not. Several thousand compounds can be found in tobacco smoke. (Table 1 illustrates the growth in our knowledge of the individual compounds present in cigarette smoke.) Similarly, some Superfund sites are known to contain as many as 600 different compounds (6). Notably, many of the hazardous chemicals found in the wastes of industrial processes also are found in cigarette smoke, as Table 2 illustrates.

Cigarette smoking has been linked to a number of health effects: lung, laryngeal, oral, esophageal, bladder, kidney, pancreatic, stomach, cervical, and endometrial cancers; heart disease; stroke; vascular disease; chronic obstructive pulmonary disease; low birth-weight infants; and peptic ulcers (3). Considering the large number of compounds in cigarette smoke (Table 1), the number of different effects should not be surprising. But individual constituents of cigarette smoke also have been identified as likely causes for several conditions. For example, 4-(methylnitrosoamino)-1-(3-pyridyl)-1-butanone is thought to play a role

in causing cancer of the oral cavity, larynx, lung, and pancreas (3).

The effects caused by cigarette smoke or exposure to other chemical mixtures often are otherwise relatively common occurrences. For example, elevated rates of cancer and poor birth outcomes are the most commonly reported effects linked to hazardous waste exposure. However, one-third of all people in the USA are expected to develop cancer, and as many as one-fourth of all pregnancies end in spontaneous abortions (7). Unfortunately, one factor for determining whether an investigation of a community exposure might be worthwhile is the uniqueness of the disease studied. The disease should be one "for which a unique and detectable class of agents has been responsible in the past. . . ." (12). The only human carcinogen to be discovered by a community study had this characteristic. The inhabitants of several small Turkish villages suffered from an extraordinarily high rate of mesothelioma, with a relative risk of 9000. An investigation of this area revealed that the townspeople were exposed to erionite, a locally occurring mineral similar to asbestos (12).

Table 3 illustrates some of the effects found in animals and/or humans after exposure to various substances. These metals, aromatic hydrocarbons, halogenated hydrocarbons, and ketones are commonly found in Superfund sites and also are present in cigarette smoke. Each individual toxin can affect more than one organ system. For example, lead is a suspected carcinogen, but it also affects the fetus, liver, kidney, brain, immune system, hematopoietic system, and heart. In addition, any one effect can be traced back to several compounds.

**Problems in Managing Risks.** It is ironic that in 1979, the Secretary of Health, Education and Welfare perceived environmental health hazards to be easier to control than cigarette smoking (16: iii):

Cigarette smoking, after all, is not like most other environmental hazards. It cannot be curbed simply through massive public and private expenditures. . . . Cigarette smoking is not subject to the same kinds of governmental regulation and control that are now used, for example, to check the emission of toxic substances into the environment.

The ensuing decade has yielded many indications that environmental health hazards are not necessarily easier to control than smoking. Indeed, the 1986 Surgeon General's report on involuntary smoking has a different tone (10: xi-xii):

[the report] . . . clearly documents that nonsmokers are placed at increased risk for developing disease as the result of exposure to environmental tobacco smoke. Critics often express that more research is required, that certain studies are flawed, or that we should delay action until more conclusive proof is produced. As both a physician and a public health official, it is my judgment that the time for delay is past; measures to protect the public health are required now.

There also has been a recognition that cleanup of hazardous waste sites is needed to protect human health. In 1990, the U.S.

**Table 3.** Effects of substances found in cigarette smoke (16) and at a hazardous waste site (18,19)

Chemical	Cancer	Developmental	Liver/ kidney	Neurological	Blood	Lung	Cardiovascular
Arsenic	X	X	X		X	X	X
Cadmium	X	X	X			X	X
Chromium	X		X			X	
Lead	X	X		X			X
Nickel	X	X				X	
Benzene	X	X	X	X	X		
Toluene		X	X	X			
Xylene		X		X			
Tetrachloroethylene	X	X	X	X			X
Trichloroethylene	X	X	X	X			
Methyl ethyl ketone	X		X		X		
Methyl isobutyl ketone	X		X		X		

Department of Health and Human Services published *Healthy People 2000: National Health Promotion and Disease Prevention Objectives*, a nearly 700-page report that was the product of more than 300 organizations with extensive review and public comment (9). In this report, one of the goals for promoting environmental health is to eliminate significant health risks posed by Superfund sites. The report states that the objective of site remediation should be to eliminate any immediate or otherwise significant health threats that have been specified in the health assessments of each site (9).

From the perspective of prevention, society has decided to minimize the risks associated with smoking by encouraging smokers to quit and by limiting circumstances where they can smoke. Government has not found it necessary to conduct risk assessments and cost-benefit analyses comparing various levels of exposures, to nonfiltered smoke, filtered smoke, and different amounts of tar, for example, in order to conclude that smoking cessation is the most efficient method for ameliorating the effects of exposure to cigarette smoke. Similarly, persons exposed to hazardous waste should be protected from exposure. Once exposure has been verified, further risk assessment is unnecessary.

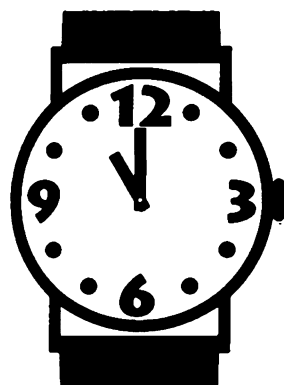
Over the past decade, a superstructure has evolved to evaluate risks posed by hazardous waste sites and to supervise remediation of Superfund sites—those sites that have been determined to pose unreasonable risks. Millions of dollars have been spent in ineffective or insufficient cleanup activities. Millions more have been spent in transaction costs (e.g., enforcement costs). A more efficient alternative is to first identify the extent of current exposure and then to prevent further exposure. Unfortunately, study

after study reveals that the Superfund program has so far succeeded at neither (6-8).

Many neighbors of Superfund sites should be considered in the same manner as involuntary smokers. These residents may be exposed to a mixture of known toxic agents, similar in many respects to the mixture that is in cigarette smoke. The role of public health agencies should be to identify those persons exposed to the compounds of concern. Having done so, the role of the regulatory agencies should be to eliminate the source of exposure or to relocate those persons exposed. No further assessment of the health risks is needed.

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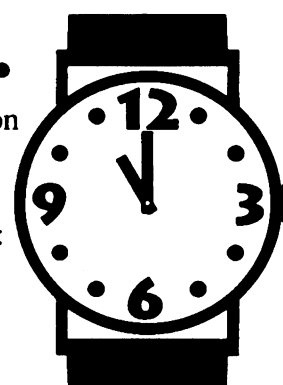
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